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The Inland Seas

Towards an Ecohistory of the Mediterranean and the Black Sea

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Ruthy Gertwagen

Towards a Maritime Eco-history of the Byzantine and Medieval Eastern Mediterranean

1. Introduction

This paper provides an introduction to the known and the unknown regarding the Byzantine and medieval marine eco-history of the eastern Mediterranean, focusing on the human aspects of fishing and fish consumption. By so doing it aims to fill the gap between the end of antiquity and the Renaissance period, both of which are periods rich with studies on the subject matter. The paper offers a multi- and interdisciplinary methodology based on documentary and archaeological evidence, noting both their limitations and their research potential. It argues that the sea and its resources played a significant role in the economy and diet of the people of the eastern Mediterranean. The chronological scope of the investigation extends from the seventh century to the end of the fifteenth. During these approximately 900 years the eastern Mediterranean experienced dynamic political, religious and cultural changes, and these changes have a direct bearing on the research task.

2. The historic, religious and cultural mosaic

Until the seventh century the eastern Mediterranean was under the domination of the Eastern Roman Empire, in modern terminology known as the Byzantine Empire. The empire was religiously Christian and culturally Roman/Hellenic; the latter element was the dominant one, with Greek being both the everyday and formal language. In 618, the Levant was separated from the Byzantine Empire for a little more than a decade due to the Persian conquest. It was, however, Arab penetration into the Mediterranean that brought profound religious and cultural changes to the region.

By the 640s, the Muslim Arabs had taken control of the southern (the Maghreb and Egypt) and eastern shores (the Levant) of the Mediterranean from the Byzantines; Antiochia (Antakya) on the Orontes river, conquered in 637/8, was now on the northeastern border with Byzantine Asia Minor. Along with political and religious changes, the southeastern Mediterranean also underwent a social and cultural 'Islamicisation'. This was a gradual process and reached its completion at the end of the seventh century with the reforms of the Umayyad Khalif Abd el-Malik (685–705). This led to the replacement of Greek by Arabic as the administrative language of government, the introduction of a new Islamic coinage and the building of Islamic monuments (although the architectural style itself was actually borrowed from Byzantine architecture). The new religion was not imposed by force on the local Byzantine/Christian population, which eventually converted in masses to Islam, with some

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exceptions such as the Copts in Egypt. Nevertheless, for those who remained Christians, Arabic took the place of Greek in the liturgy and was used in literature and in everyday life. According to the Muslim geographer al-Muqqadasi (c. 940–90), in his time, 'the scribes here [in Syria and Palestine] as in Egypt, are Christians, the Muslims simply depending on their knowledge of their language'.[1] In other words, over time, the Islamic conquests transformed the identity of the local population in the southeastern Mediterranean region.[2]

The second phase of Islamic conquest of Byzantine territory took place in the late eleventh century when Seljuk Turkic tribes conquered Asia Minor. From his base in northwestern Anatolia, Osman (died 1326), the founder of the Ottoman dynasty, began a process of conquest that extended the area of Ottoman rule from northwestern Asia Minor into Byzantine territory in Thrace, the Gallipoli peninsula, the Balkans and what is now Greece; it was completed by the conquest of the Byzantine capital, Constantinople, in 1453 and the Black Sea coast in the 1470s.[3]

Among other consequences, the Seljuk conquest of Asia Minor in the late eleventh century helped prompt the Crusades, which, from the end of the eleventh and the beginning of the twelfth century, resulted in the formation of the Crusader kingdoms in the Levant. The Crusaders, along with the populations of the merchant colonies established in the Crusader Levant by the Italian city-states of Venice, Genoa and Pisa, and later of other southern European cities, like Marseille, were of course Christians, belonging to the Western ('Catholic') Church. They did not impose their religion or culture on the local Byzantine (Eastern Orthodox) or Muslim populations. With the final defeat of the Crusader states in the Levant at the end of the thirteenth century by the Mamluks of Egypt, the whole area was once again under Muslim control; after the Ottoman conquest of Egypt in 1517 it was part of the Ottoman Empire.[4]

From the fourteenth century, Muslims dominated in Asia Minor, the Levant, Egypt and North Africa, while Christians maintained control over the Aegean and Ionian Seas, the Peloponnese and mainland Greece until the late fifteenth century. The Fourth Crusade ended in 1204 with the capture of Constantinople by the crusaders and the Venetians was followed by the creation of the 'Latin Empire' and various Venetian possessions in the Ionian and Aegean Seas that much later (from the 1380s) evolved into a Venetian maritime empire at the expense of the former Byzantine territories. Despite the Byzantine re-conquest of Constantinople in 1261, the Ionian and Aegean Seas and most of the Peloponnese, the Greek mainland and the Black Sea remained under Latin and Venetian rule. After 1261, the Genoese established their dominion in the northeastern Aegean in Constantinople and the Black Sea region.[5]

The writing of a comprehensive study of the marine ecological and environmental history of the medieval eastern Mediterranean involves the reading of multiple types of published and archival documents in many languages and dialects: Greek, Latin, Arabic, German, French, Genoese and Venetian, to name a few. Along with local Byzantine and Arabic sources, Western archives too need to be studied in order to understand the eco-history and

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[1] Al Muqaddasi (transl. Collins 1994): 166.

[2] Grabar 1987: 1–18; Kennedy 1988: 98–9; Whitcomb 1995: 49.

[3] Imber 1990; 2002: 1–42.

[4] Smail 1973.

[5] Lane 1974; Balard 1978; Gertwagen 2014.

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human impact on the environment, including fishing. Deciphering the various medieval archival documents, requires specialist palaeographic skills. The language and script found in Renaissance documents more often resemble modern forms and language. This complexity of the documentary material would seem to be the reason behind the claim, often made by European scholars involved in this field of research, but occupied with the early modern period, that in the Middle Ages the fishing skills of the Roman period had been forgotten.[6] The neglect of the medieval period is very conspicuous, for instance, in Roesti's study on the economic role of Mediterranean tuna fishing since early antiquity. After a systematic review of the subject matter from prehistoric times until AD 476 (the date he selects for the end of the Roman Empire), the author goes on to describe the situation in the seventeenth century.[7] Nevertheless, a small number of studies drawing on historic documents, even if they do not discuss fisheries specifically or directly, attest to a rich marine fauna and to intensive sea fishing in the medieval eastern Mediterranean.

3. The Byzantine world and the Black Sea

The great bulk of studies based on historic evidence published so far concern the Byzantine world, covering, in a sporadic fashion, the period from the seventh century until the conquest of Constantinople by the Ottomans in 1453.

The variety of Byzantine sources includes: history, literary works (poetry and letters) and legal documents, as well as Greek texts on aspects of pharmacology and dietetics; these texts discuss fishing and marine animals as part of their consideration of culinary habits and the nourishing and health qualities of food items in general. The texts are partly translated into English and analysed in Andrew Dalby's stimulating book on *Flavours of Byzantium* (2003) and by Alice-Mary Talbot in her paper, 'Mealtime in monasteries' (2007). Maria Chrone-Vakalopoulos and Angelos Vakalopoulos (2008) discuss the works of Byzantine doctors and the so-called *Geoponica*. The authors present the terminology used for fish and various other aquatic species in all the Byzantine sources available and identify each species with its current scientific name. They note that more than a 110 names of fish and about 30 names of other marine creatures are found in the Byzantine literature, mostly in medical texts. Their identifications are based partly on the categorisation provided by some of the sources, but mainly on parameters related to the physiology of the species, as described in modern ichthyology.[8]

Legal texts, such as the *Book of the Eparch*, compiled in the early tenth century, and the *Basilica*, a revised version of the Justinianic Codex issued by the emperor Leo VI (886–912), as well as later revisions of the *Basilica* in the mid twelfth to fourteenth century, shed light on several issues: new definitions of public and open marine spaces and the depth for fishing, on the one hand, and, on the other, the protection of private property rights where none existed before and the distances between fisheries (see Lytle, this volume). The geographic zones concerned are Constantinople and the Bosphorus to the north and the Sea of Marmara to the south. Other issues dealt with are the organisation and operation of the fish markets at Constantinople and the nature of the interactions of the players involved. In his

[6] De Nicolò 2011.

[7] Roesti 1966.

[8] Chrone-Vakalopoulos and Vakalopoulos 2008.

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instructive study, Gilbert Dagron[9] extensively analyses the connections between the various fish genera, the fishing devices, the specific geographic environment of Constantinople and the revisions of the existing laws made by Leo VI. He also shows that similar situations, regarding both fishing gear and fishing rights, existed in early twentieth-century Istanbul/Constantinople. George V. Maniatis, in a thorough research paper, interprets and supplements the relevant sections of the various law texts with sound economic analysis and offers references to social matters.[10]

One of the striking facts yielded by these sources is the richness of the marine fauna that characterised the northeastern Mediterranean. Fish were classified according to quality, health, digestion and origin: marine or freshwater.[11] High-quality fish were considered 'white fish' (*leukoi ichthys*); these were in limited supply and therefore of relatively high price. 'White' sea fish included red snapper (*Lutjanus campechanus*), grey snapper (*Lutjanidae*), red mullet (*mullus barbatus*) – although these were regarded as rather coarse – sea bass and porgy (*Chrysophrys*), known also in the Mediterranean as sea bream. Other species considered 'white fish' include both freshwater and marine species: surmullet (*Mullus surmuletus*) and sturgeon *mourozoulin* and *berzitikon* that were imported to Constantinople from the northern Black Sea, even long after the Byzantines had lost their hold on this area. In Italian, salted and dried sturgeon fillets were – according to the fourteenth-century Florentine Francesco Balducci Pegolotti's trade manual – known as *schienali* and they were shipped in large quantities from Tana to Constantinople, and especially to Pera, the Genoese quarter of the city. They were brought overland to Tana from the Caspian Sea and the Volga river.[12] According to the Spanish traveller and ambassador to the Tatars, Pero Tafur, who was a contemporary of Pegolotti, large quantities of fish, especially sturgeon, were taken on board ships and carried as far as Castile and Flanders.[13] In the fifteenth century, great sturgeon, *morone*, from the northern Black Sea were exported through Constantinople to Crete.[14] The eggs from this fish were processed for caviar.

Among the inferior genera of deep-sea and inshore white fish were marlin (*Istiophoridae*) – also spearfish (*Tetrapturus pfluegeri*), swordfish (*xiphias gladius*), skate and cartilaginous fish: the sting ray and electric ray of the same family that are less favoured nowadays. Also esteemed was the monkfish, presently known in the Mediterranean also as anglerfish and angler. Although a bit hard to digest, it was very nourishing. Other fish were the dogfish and the various genera of grey mullet, both marine and freshwater, which were considered unhealthy since they customarily feed on mud; guitar-fish, sole and plaice were thought to be moderately productive of both good and bad humours. On the other hand, the fish of the Scombroid family were considered to be of the lowest quality; these include mackerel and various types of tuna, the albacore (*Thunnus alalunga*), palamide and bonito. They are

[9] Dagron 1995; Talbot 2007.

[10] Maniatis 2000, esp. 16 concerning some of Maniatis' reservations regarding Dagron's interpretations.

[11] For the Greek terminology as it appears in the various Greek sources, see Dalby 2003: 185–237; Chrone-Vakalopoulos and Vakalopoulos 2008.

[12] Balducci Pegolotti, *Pratica* (ed. Evans 1938): 380; Tzavara 2004: 813–4.

[13] Tafur, *Travels* (transl. Letts 1926): 135.

[14] Jacoby 2009: 367

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described as stinking, crummy, lean, foul, heavy, indigestible, unwholesome and a cause constipation and flatulence. Therefore they were to be eaten pickled or salted.[15]

Other marine animals that were considered high quality and sought after were the various types of crabs (*karkinoi, pagoryroi*), lobsters and cuttlefish, shrimps, octopuses and squid, as well as a range of other shellfish: oysters, mussels, scallops, cockles and winkles. Although favoured and nourishing, all these species were considered indigestible; only when boiled and with the liquid drained off were they considered highly as an aid to getting the digestion under control.[16]

Consumption of different species is attested for different social levels, both lay and religious, including monasteries. According to the twelfth-century satirical poem by an author calling himself Ptochoprodromos, addressed to the emperor Manuel I Comnenus,[17] and to European travellers, such as the Catalan Pero Tafur, of the fifteenth century, members of the 'high society', so to speak, including bishops and abbots, during Lent and on fast days (totalling 200 days of the calendar year) when meat was not permitted on the table, ate the highly-prized bloodless fish: shellfish such as lobsters, crabs, pan-fried prawns, oysters, mussels and stewed crayfish. The humble monks, on the other hand, ate 'holy soup' that consisted of boiled water with onions tossed in and three splashes of oil that was poured over their bread.[18] Due to the low prices of oily fish, the ordinary lay and poor people ate them; they would also have eaten them on fast days as well, since low-income families would have had no other alternative.[19]

The early tenth-century, *The Book of the Eparch*, mentioned above, prohibited the residents of Constantinople from buying fish directly from the fishermen; fish could be purchased only through the fish merchants in the city market. Thus there were two fish markets: a wholesale one at the waterfront, where the fish merchants bought from the fishermen, and a retail market, in the city. The fish were to be sold fresh; salting for export was prohibited. The prohibition itself attests undoubtedly to the opposite being the common habit. The documents indicate a rich activity of selling fresh fish in the fishing grounds of the Sea of Marmara and the Black Sea. In the late ninth and early tenth centuries, the *Basilica* and its later revisions took steps to promote the utilisation of all suitable shorelines and their sustainable development, to encourage proper management and to ensure the accessibility of necessary investments in fixed and working capital.[20]

The law stipulated the quota of daily fresh fish to be offered on the retail market, while the surplus fish were to be salted, pickled in brine or vinegar or dried, to prevent spoilage. The highest production levels were mainly achieved during seasonal migration peaks. The migrating fish that were cured included sardine, tuna, mackerel, swordfish and grey mullet. The processing stage, however, was a separate activity from the fishing, undertaken by in-

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[15] On the health and nutrition qualities that were included in texts compiled in the seventh century, see Dalby 2003: 68–9, 145–6, 148, 150, 154–60; Chrone-Vakalopoulos and Vakalopoulos 2008. On 'white fish' and the lowest-quality fish, see Maniatis 2000: 29, nos 68–9.

[16] Dalby 2003: 67, 148, 153; Chrone-Vakalopoulos and Vakalopoulos 2008.

[17] Ptochoprodromos (transl. Eideneier 1991): 4.325–6 and 4.93 respectively (= p. 157 and 144); Talbot 2007: 114, 118.

[18] Tafur, *Travels* (transl. Letts 1926): 119.

[19] Maniatis 2000: 37, n. 86.

[20] Maniatis 2000: 14–8, 40–1; *Book of the Eparch* 17 cited in Dalby 2003: 65.

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dependent businessmen; it required basic technical skills, equipment and tools, processing facilities in the form of sheds and working capital for operating expenses. Consequently, an active market for the preservation of fish developed, with adequate storage space that eased the pressure of excess of supply. Moreover, to prevent the waste of an essential nutritional resource, it led to an attendant price structure for certain varieties of processed fish.[21]

The Byzantine documents refer also to fishing techniques. These, according to Dagron, have continued from Byzantine times to the present day. They vary from fishing with harpoons or tridents to the use of baskets (for crabs and shellfish), rods, nets thrown by individuals and nets pulled by boats to encircle the fish, nets cast overnight and fixed nets anchored on poles driven into the sea floor in shallow sea waters, lagoons and river estuaries. The latter were very useful during migration periods.

The first migration period begins around April, passing from the Sea of Marmara into the Black Sea, where it ends on its northern coast in July. The first to migrate are mackerel, followed by tuna (adults), palamide (of around one year in age) and bonito (the very young ones). In September, the period of reverse migration from the Black Sea to the Sea of Marmara begins, ending in November. The first to migrate out are tuna, palamide and bonito, followed by mackerel, which might also stay at the Bosphorus.

The straits provided rich fishing grounds for migratory fish, and there were two main types of fixed nets used to exploit this. Those used in shallow water (*aulakia*, *gripoi*, *gripobolia*) were nets consisting of compartments in the shape of a funnel. In deeper water, the fishermen formed an enclosure (*époche*, Turkish *dalyan)* made from nets stretched on beams, with an entrance that is closed after the fish have entered the 'trap'. Near the enclosure there would have been several watchmen's huts on poles, from which the patron could watch the movement of the fish and so time his order to close the trap.[22] One can speculate that this was the role of the tenth-century stylite Loucas, whose column stood at the sea's edge near Chalcedon. This, and not only his blessing, from the top of his column, of the net installations that the fishermen set up nearby, would explain the tithe of fish he received as tribute.[23]

In addition to fish, crab and other fruits of the sea, there were two other marine-based products on the Byzantine menu. One was fermented fish sauce, *garum* or *liquamen.* It may have originated in the early Greek colonies in the northern Black Sea (Bekker-Nielsen, this volume) and later became ubiquitous. Whilst it had been forgotten in the West by the tenth century, it was still being prepared in Constantinople in the early sixteenth century, then under Ottoman rule since 1453.[24] The Ottoman conquest did not affect the culinary mentality and habits of the conquered Byzantine population, which the Ottomans did not dislike.

Another ichthyic product appreciated by the Byzantines as well as across the Aegean region and western Europe was the various types of caviar. One was made from grey mullet and tuna roe, *ootarikhon* or *botargo* in modern terminology, dried and cured in sea salt for few weeks.[25] Another was red/pink caviar and a third was black caviar. According to the

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[21] Maniatis 2000, 21, 30–32.

[22] Dagron 1995, 60–63 and figs 1–4; 2002, 458–9.

[23] Delehaye, *Les saints stylites*, ch. 16, 212–3.

[24] Dalby 2003, 27, 67–9; Dagron 2002, 448 and n. 320 on ancient periods, see Bekker-Nielsen 2008.

[25] Dalby 2003, 67; Jacoby 2008. Unlike Jacoby who claims that the only source of the *botargo* was

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twelfth-century archbishop Eustathius of Thessaloniki, red or pink caviar was made from the roe of salmon; it was pressed into bricks and served in slices. Black caviar, in contrast, was served in loose heaps in wicker baskets. The same Eustathius notes that black caviar originated from Tana on the Don river and emphasises that it was a choice product;[26] there was another market in the northern Black Sea, in Lo Copa at the mouth of the Kuban river, coming from the northern Caucasus into the Sea of Azov.[27] Both markets were seasonal, connected to the migration patterns of fish: Lo Copa operated from spring until the end of May and Tana from July until the departure of the northern Italian, mainly Genoese and Venetian, merchant convoys in early September. The caviar was exported in barrels or baskets by ship to Constantinople, the Aegean area, Europe, the western Mediterranean and through the Strait of Gibraltar to Flanders.[28] According to the fourteenth-century trade manual of Pegolotti, at market the caviar was sold stuffed into the tail half of a fish skin, called *fusco* in Italian.[29]

In contrast to the rich evidence for the export of fish and caviar provided both by Byzantine and later western European texts, documents regarding the processing industry, its facilities and manpower, still need to be studied thoroughly. From the few archival sources so far considered, it is clear that the key players in this industry were the Byzantines and Tatars.[30] Regarding processing techniques, the only evidence so far available (which highlights the promise of further investigation of the archival material) is provided by the fifteenth-century Spaniard Pero Tafur, who writes:

> They kill there certain fish which they call *merona* and say that they are very large, and they put the eggs into casks and carry them for sale all over the world, especially to Greece and Turkey, and call them caviar. The eggs look at first like black soap, and they take them when they are soft and they press them with a knife, as soap here [in Spain], and put them into braziers, which makes them hard and look like the eggs of fish. This stuff is very salty.[31]

In Ottoman Bursa, caviar was served with olive oil. Bertrandon de la Broquiere, who visited the town on a fact-finding mission in 1432 on behalf of Duke Philip the Good of Burgundy, found it detestable.[32] It seems that despite their nomadic origin, the Ottomans adopted Byzantine marine dishes, even the very salty ones like caviar and *garum*. One can safely speculate that the Ottoman archives might shed further light on this aspect of Ottoman culinary habits, and related economic and social issues.

No similar modern study of the marine environment and ecology, based on Byzantine texts as well as on later Western documents, exists for other parts of the Byzantine world, around the Ionian and Aegean Seas, and in the southeastern Mediterranean. At face value,

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the Caspian Sea, evidence introduced below points to the availability and distribution of both species in the south-eastern Mediterranean.

[26] Eustathius of Thessaloniki (ed. Metzler 2006), 66; Jacoby 2008.

[27] Berindei and Veinstein 1976: 130–1; Balard 1978: II, 706–7.

[28] On trading patterns, see Balletto 1976: 390–476; Balard 1978: II, 207; Tzavara 2004; followed by Jacoby 2008.

[29] Pegolotti (ed. Evans 1938): 24

[30] Balard 1978: II, 707, n. 29.

[31] Tafur, *Travels* (transl. Letts 1926): 135.

[32] Bertrandon de la Broquiere, *Voyage* (ed. Schefer 1892): 135.

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it seems that fish were mainly consumed in Constantinople. Dagron argues that the role of fish in the diet of this area was a function of geographic circumstances, which were especially favourable to Constantinople. Therefore fish compensated for recurrent wheat shortages in the city.[33] However, there are similar environmental and geographic settings, for example the Dardanelles or Chalcis/Euboea in the northern section of the central Aegean. In many respects, Byzantine research, as noted by Dalby in the preface to his book, is still a wide open field, and there is much more information waiting to be gathered and utilised. Dalby refers specifically to our ignorance of the rules of daily life for the residents of monasteries regarding culinary habits,[34] but the sources may also contribute to our understanding of the marine environment, eco-history and various aspects of fishing across the whole Byzantine eastern Mediterranean. Echoes of such evidence can be found, for instance, in linguistics. The Greek term for egg pickle adapted for salted grey mullet roe is *ootarikhon.* It is the Greek source of Coptic *outarakhon*. The Copts were and are the Monophysite Christian population of Egypt. The Coptic term was adapted into Arabic as *butarkha*[35] which resembles the sound of Italian *botargo.* This linguistic evidence argues for the fishing of mullet and tuna around Egypt and the processing of their roe as caviar in both the Byzantine and the following Muslim periods, from the seventh century AD. The question is: what documentary and ichthyo-archaeological evidence do we have to support this argument?

4. The Muslim world

The early Muslim evidence that deals with our subject matter mainly includes geographic works and travellers' accounts. These, however, emerge only from the late ninth century, along with the first administrative sources.[36] The study of administrative texts may provide evidence regarding taxes and regulations imposed on the fishing industry. Nevertheless, there is a gap of 200 years between the arrival of the Arabs and the date of these Muslim documents. To fill this gap we should, from a historical point of view, continue to consult Byzantine or local Greek documents.

As far as I know, there are no modern studies devoted entirely to fishing in the early Muslim period. Eliahu Ashtor's thorough paper (1968) on the dietary habits of the various social classes of the Middle East from the tenth century onwards does deal with fish. Despite its title, the author focuses mainly on fish in Egypt. The early Muslim as well as western European documents of the fourteenth and fifteenth centuries that Ashtor gathers together yield interesting, if partial, information regarding fishing. According to these sources, fish were very cheap compared to meat and were, therefore, consumed by the poorer classes. Both the Muslim geographers and the western travellers praise the fishing grounds along the Mediterranean coast of Egypt and those of the Nile. The works of Ibn Hawqal and al-Muqaddasī, based on first-hand observations made in the tenth century, describe the sea fish sold at al-Farmā or Pelusium on the Nile delta; Yāqūt in the thirteenth century counted 79 species of marine fish caught around Tinnis.

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[33] Dagron 1995: 447.

[34] Dalby 2003: 7; although there are some studies on the subject, such as Talbot 2007.

[35] Dalby 2009: 67

[36] On the principal sources for the history of the Near East, 600–1050, see Kennedy 1988: 350–88, esp. 371–2 for geographical sources and travellers' reports.

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The medical doctor al Mukhtār b. ʿbdūn Ibn Butlān, of Christian origin, who in 1047 travelled from Baghdad to Cairo, reported that salt fish was sold at Tinnis and considered expensive; it was, therefore, served on the tables of the rich. In 1339 a high-ranking individual in Tinnis bought 200 jugs of salt fish. Another medical doctor of the late twelfth century reports that poor people ate small fish and fish spreads. He also indicates that a lot of fish was sold at Damietta, which was cooked with the same ingredients which were used with meat. Western travellers of the fourteenth century admired the fish around Damietta, which were salted and sent by camel all over Egypt.[37] These salt fish were appreciated by the rich. This picture regarding salt fish as a delicacy reserved for the tables of the wealthy sits in sharp contrast to the one outlined above for Europe and Byzantium.

The historical evidence presented by Ashtor regarding the subject matter of this paper is limited, since it is not his main interest. Nevertheless his source references are important and, if studied thoroughly, they may reveal details about the various fish species, fishing and fish-processing techniques and devices, marketing and export, and storage. For instance, in the last quarter of the tenth century Ibn Hawqal referred to a story, written by a person whom he considered stupid, about a certain fish around Alexandria called *arus* that was beautiful in appearance, covered with stripes and very tasty. According to the story, if a man ate the fish, he would dream of having homosexual relations or that many black people started relations with him, unless he drank water with honey or ate a lot of honey. Ibn Hawqal claims that he and others ate this fish and did not have such dreams, which proved the stories to be false. As we shall see below, a version of this story was repeated in the twelfth century by Idrīsī. Ibn Hawqal also describes in detail the deep lagoon around Tinnis and Damietta, its depth, its water circulation and the effect on fish. During summer, when the Nile rose, the water in the lagoon was fresh. During the winter, when the Nile level decreased, seawater entered the lagoon along with marine animals such as dolphins, which were abundant along the Mediterranean coast.[38]

Interestingly, the water system of this lagoon is also described, from another perspective, in the *Book of Curiosities*, which was probably compiled by an inhabitant of Tinnis in the first half of the eleventh century, i. e. almost half a century after Ibn Hawqal. Every year, the salt waters of the lagoon were driven out to sea by the fresh waters of the rising Nile. Inlets, depicted on the annotated diagram that accompanies the text, allowed the flood water to refill the huge cisterns on which the city depended for its water supply. Although the author's text does not include any reference to fish, he does depict a fish market on the diagram.[39]

The geography and map of the Mediterranean by al-Idrīrsī (1099–1165), not discussed in Ashtor's paper, describes the marine fish which used to enter the Nile. According to Idrīrsī, there were many species, but he names only three. The first was the *al-buri* or the grey mullet, with a beautiful colour. As mentioned earlier, mullet roe had been processed since Byzantine times by the Copts, who called the resulting product *outarakhon*, cf. modern *botargo*. The identification of the other two species is not certain. One was the *al-shabel*, perhaps *Clupea alosa.* It was one cubit long, beautiful and oily. The other species, the *shabbût*, was a small variation of the former.

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[37] Ashtor 1968: 1033–4.

[38] Ibn Hawqal (transl. Kramers and Wiet 1967): I, 154; on his writing, sources and importance among Arab geographers, see Kramers' and Wiet's introduction: I, 9–17.

[39] Johns and Savage-Smith 2003: 18, fig. 4.

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Around Rosette (modern Rashid), there was a type of a small shell fish, called *telline*, with a shell and dark, speckled meat. This was said to reproduce at the mouth of the Nile, where salt water mixed with fresh. The people of Rosette used to catch a great number of these at the time of their reproduction, then salt them for distribution across Egypt. This was an important element of the city's commercial activity.

Around Alexandria, an unidentified species, depicted with stripes – *arus* – was fished. According to the popular tradition, already mentioned, if it were eaten grilled or boiled without drinking or eating much honey it was said to arouse sexual desire. Al-Idrīrsī did not himself visit Egypt or many of the other places he describes; he relied on information provided to him by traders, travellers and captains, or he used earlier written works, and he might well have used the work of Ibn Hawqal.[40]

The Geniza letters, which form a most important source for understanding commerce and industry in Egypt and the Mediterranean from the late tenth and early eleventh century until the fourteenth century, yield additional details.[41] Since the Geniza letters concern primarily members of the Jewish community in Egypt, we can learn from them about the active role of Jews in fishing, as attested also by the family names of fishermen and fishmongers. Those specializing in tuna fish were named *tunnī* or *tawān*; we can assume that they were also engaged in producing *botargo* from tuna roe. Tuna was a sought-after sea fish. There is a letter about dispatching a glass jar with minced fish pickles from Alexandria to Old Cairo[42] and salted tuna fish sent as a present from Qayrawān in Tunisia again to Old Cairo and also from Barqa in eastern Libya.[43] Some Jews specialised in carp pickles and in the popular little salt fish.

Another category of Jews involved in the fishing industry was the shellfish gatherers. These were called *mah(h)ārī* and their base was at Alexandria, from where they were dispatched to the Levantine coast. Shellfish were used both for food and 'industry'. Since the eating of shellfish is forbidden to Jews, the shellfish they gathered for themselves must have been intended for other purposes: dyeing cloth and silk (cf. Alfaro, this volume). The dyeing process, whose roots can be traced back to the Minoans and Phoenicians along the Levantine coast, was a smelly activity and therefore located outside the urban centres.[44] The silk industry and its sub-industries were common in Egypt, as indicated by a list of textile occupations according to city, region and century collected by Maya Shatzmiller from

[40] Al-Idrīsī (trans. Jaubert 1999): 85–7 on fish in the Nile, 87–8 on fish that enter the Nile from the sea, 241 on fishing around Raschid, 242 on fishing around Alexandria, 19–20 on Idrīsī's style and sources of information. Like Ibn Hawqal, he also describes the marine animal populations of the Nile, yet he lingers on the crocodile and hippopotamus: 85–7; Ibn Hawqal's descriptions, however, are more elaborate and include another species, the electric fish: Ibn Hawqal (transl. Kramers and Wiet 1967): I, 146–7.

[41] For a general discussion of the Geniza records and their contribution to an understanding of economic life, see Goitein 1967: 11–2, 17–21.

[42] Goitein 1967: 126, n. 84–6.

[43] Goitein 1973: 117.

[44] On oyster-gatherers, see Frenkel 2006: 185, 351–8 doc. 30 (late twelfth century), 533–5 doc. 71 (early thirteenth century). On ancient dye from shellfish, see Jensen 1963: 104–18 (the article starts with the Minoan period in Crete). See also Cooksey 2001: 736–69; more recently Alfaro and Mylona 2014: 149–68, 150, n. 8.

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Arabic documents of the ninth to the end of the fourteenth century.[45] Still, these were only a very small percentage of the large number of occupations of the medieval Middle East. The Jews, however, played a major role in the silk industry, both under state control and in the private sector. In the southern Mediterranean, Mahdia near Tunisia and Egypt were the main centres.[46]

One could also argue that shellfish gathering by Jews fulfilled a specific Jewish need for two colours of threads for the fringe (*ṣiṣit*) of a prayer shawl (*tallit*). One was the bluish *tekhelet* produced from the *hexaplex trunculus,* which is abundant in the shallow offshore waters between Tyre and Haifa. A *tallit* with 24 grammes of woollen *ṣiṣit* required the dye of nearly 200 snails for the *tekhelet* threads. The other half of the threads were dyed the purple *argaman* colour, which was produced from *Murex brandaris* and *purpura haemastoma.*[47]

Corals were also traded by Jewish merchants, who exported them from the Mediterranean to the Indian Ocean. They were collected partly from Tunisia and partly from the coasts of southern Europe. Alexandria in Egypt was the reloading port.[48]

In the early fourteenth century, Ibn Battûta, a Muslim traveler who on his journey from north Africa to Mecca passed through Egypt, recorded two types of marine species in Damietta. One was marine birds, which he indicated to be abundant and greasy but he omitted to mention their names. The other species was the *buri* fish, which according to his information was exported from Damietta to Syria, Asia Minor and Cairo.[49]

In contrast to the information that the Muslim geographers and travellers provide on the fish trade in Egypt, they have nothing to say about that along the Levantine coast (present-day Israel and Lebanon). Ibn Hawqal and al-Muqaddasi both describe urban settlements and hinterlands, the environment, rivers and climate, and details of agricultural products.[50] The Persian traveller Nāṣir Khusrau (c. 1004–1088) describes in his diary the Levantine coastal towns as an eyewitness and provides information about, among other things, the conditions and economies of the countries he passed through; he too ignores the topic of fishing. Even for Tinnis, in contrast to his very detailed descriptions of daily life, the economy, climate, water and food, Khusrau completely ignores the fisheries for which the town was famous.[51] Considering that al-Muqaddasi only indicates as a matter of fact that fish were appreciated in Tinnis, and that both he and Khusrau refer in detail to other environmental topics in the Levant and Egypt, one may conclude that fishing was not one of their interests. On the other hand, the neglect of the subject regarding the Levantine coast by Ibn Hawqal is intriguing. The same goes for Ibn Battûta who also visited and described the coastal towns of the Levant in the early fourteenth century, but took no interest in marine species, nor fishing activies.[52]

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[45] Schatzmiller 1994: 101, 103, 119.

[46] Goitein 1967: esp. 100, 116.

[47] Spanier 1987: 63–4, 214–5.

[48] Goitein 1967: 47

[49] Ibn Batûta (transl. C. Defremery and B. R. Sanguinetti 1958; new edtion 1994): 116.

[50] Ibn Hawqal (transl. Kramers and Wiet 1967): 163–86; al-Muqaddasi (transl. Collins 1994): 148–50, 157–8.

[51] Naṣir Khosrau, *Sefer Nameh* (transl. Schefer 1881): 44–63 on the Levantine coast from Beirut down to and including Caesarea; 109 on the area from Ascalon to Tinnis; 110–15 on Tinnis alone.

[52] Batûta (transl. C. Defremery and B. R. Sanguinetti 1958; new edtion 1994): 167–68.

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Indeed, al-Idrīsī in the mid twelfth century also ignores fishing along the Levantine coast. Since he never visited the region himself but relied on the accounts of others for information, one may conclude that fishing was not a subject of interest to his informants. It should also be pointed out that the descriptions of the Levantine urban centres in Idrīsī's *opus*, including the coastal towns, are far from uniform.[53]

On the other hand, in one of the Geniza letters the writer describes with horror shellfish gatherers from Alexandria drinking beer in Crusader taverns in twelfth-century Acre. According to this letter, men belonging to the lowest level of society gathered shellfish at Haifa, which the writer calls by its Greek name, Porphyrion, 'the town of the purple snail'.[54]

5. Western European sources

Although the Geniza documents, cited above, are the only evidence so far for a marine species fished in the Crusader Levant, other sources, mainly from the second half of the thirteenth century, do refer to fishing activities carried out by 'citizens' of the Italian communes (i. e., born locally or immigrants from Europe), mainly in Acre, the capital and main port of the second Crusader kingdom (1191–1291). The locals were native Pisans, called *poulains*, who had their own boats: 'Barques de pesqours, poulains pizans'.[55] Others were Genoese. In 1255 a partnership contract, *societas*, was made between two Genoese in Genoa for a voyage to the Levant, possibly to Acre, to work in fishing for a year. The dates stipulated for the extension of the contract were set by the navigation seasons. The parties were to buy and share the necessary equipment – net, boat and other utensils (which are described in detail) – at their destination port. The net was a seine that could be cast and stay on the sea floor. They intend also to enroll local help.[56] A commercial contract drawn up in Genoa twelve years later by a merchant leaving for the Levant discusses an investment in ropes or lines used in fishing, *in cordis piscandi*.[57]

This evidence points to abundant fishing grounds in the Levant which would justify emigration from Genoa for this purpose; it also points to a prosperous local fishing industry. Furthermore, it suggests the promising prospect of studying notary acts in European archives, since there were no such archives in the Crusader kingdom itself. Notary acts are crucial since they deal with a wide spectrum of daily activity. To illuminate the local Crusader perspective, a thorough study of the administrative acts of the kingdom or of local contemporary chronicles will be required.

Travellers' accounts are another category of potentially informative sources. Some of them indicate places of rich fish catches, others mention the names of fish species and the methods to catch them or they enumerate the species encountered at different locations. In 1394–1395, an Italian notary named Nicolas de Martoni made a pilgrimage to the Holy Land. On his way back, he refers to fishing boats at Negroponte (Chalkis, on the island of

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53 Al-Idrīsī (transl. Jaubert 1836–40): 339–49.

54 Goitein 1967: I, 127, n. 87.

55 *Gestes des Chiprois* (ed. Raynaud 1887): 227, n. 554 cited in Gertwagen 1996: 568, n. 77; Jacoby 2005: 73–105, n. 91.

56 Balletto 1973: 197, 205–6, n. 3. I would like to thank Laura Balletto for sending me her book.

57 Balletto 1986: 207.

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Euboea), in the north central Aegean.[58] In the late fifteenth century a German pilgrim, the Dominican friar Felix Faber, remarked on arriving at Jaffa:

> I know not what conditions of the air or water or other elements, that the fishes swam on the top of the sea and showed themselves on the surface more than they wont. There we beheld wondrous fishes. Some were large and quite round, like a winnowing-fan. Some had heads like dogs, with long ears hanging down [… *quidam habebant capita canina cum auribus longis dependentibus*] and we saw many dolphins that morning, and saw them more plainly than ever before.[59]

Given that Faber was a pilgrim without marine biological skills, some of his descriptions of particular marine species would be inaccurate to say the least, if not imaginary. If he really meant to describe dogfish, to illustrate the idea he may have added further details, such as the ears typical of terrestrial dogs. In any case, the scarcity of dogfish and dolphins along the Israeli coast nowadays, in contrast to their presence in the fifteenth century, requires further studies of the reason for this radical change.

A similar description of fishing for large sharks and a sea turtle is provided by another pilgrim, Canon Pietro Casola. Arriving at Jaffa on board a Venetian pilgrim galley in July 1494, all were detained on board by the Mamelukes for several days. Being hungry and frustrated, the captain decided to provide some amusement by way of fishing. The following is the detailed description of fishing the shark:

> On this day, with certain contrivances of very strong cord and great hooks, an immense fish was caught. There was great difficulty in hauling it out of the water, because it defended itself boldly … so that is was necessary to hold it thus tied in the water until it was exhausted. The hook was so big so that it took a large sheep's lung to bait it. The men wounded the fish with certain iron weapons suitable for the purpose … Afterwards it was found to be a shark.[60]

Another type of evidence are the accounts of naval expeditions. The late medieval warships were of the galley type: long, heavy ships rowed with oars. They were additionally rigged with large lateen sails for the voyage to the battlefield or during routine sailing with favourable winds. Rowing, as well as manoeuvring the sails and the large rudders, demanded lots of energy. The diet of warships demonstrates the attention, based on experience, given to every food item and its importance, although without 'scientific' reasoning. Ships' biscuits provided glucose and formed the basis of the seaman's diet. This also included vegetables or legumes, which provided B vitamins and minerals, and onions and garlic, which contained vitamin B and C complexes, anti-oxidants, anti-dermatomycosis and anti-viral agents, and minerals. Fruit contained mainly vitamins. Olive oil provided omega 9. Rice provided vitamin B complexes and minerals. Wine softened the hard biscuit and ameliorated the tastelessness of the food. Proteins were provided as cheese and salted meat or fish, mainly sardines. Sardines were a popular species, since they could be eaten with the bones and without cooking, and kept salted in barrels. They also provided calcium and iodine, vital for the

[58] Martoni, *Relation* (ed. Le Grand 1895): 578, 654.

[59] Felix Faber, *Fratris Felicis Fabri Evagatorium* (ed. Hassler 1843), p. 191 = f. 74b.

[60] *Canon Pietro Casola's pilgrimage to Jerusalem in the year 1494* (ed. and transl. M.M. Newett, 1907): 225–26.

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metabolism. Sardines were consumed by the higher ranks, especially on Fridays when meat was forbidden.[61]

The account of the Mediterranean military expedition of Henry Earl of Derby, later Henry IV, in 1391–1392, itemises species bought en route and the locations of their purchase. At Corfu, fresh fish were bought during two visits, including Mediterranean moray. At Modon in the southwestern Peloponnese, 48 large eels and, during another visit, 100 eels and fresh fish were purchased. At Rhodes, fresh fish were acquired. At Famagusta on Cyprus, 100 eels, 102 salted eels, Mediterranean moray as well as other salted fish and fresh fish, cuttlefish, 58 salted sturgeons (originating from the northern Black Sea, these must have been imported to Cyprus), 104 varied salted fish, 103 *skombri* or mackerels and Mediterranean moray were purchased. At Jaffa, fish and, during another visit, various salted fish were bought privately by the crew serving on the galley and by the earl's staff along with fresh fish. In Alexandria, 50 Mediterranean morays were acquired. Sturgeon caviar, eels and Mediterranean moray were considered luxurious, and during Lent were eaten only by the upper classes.[62]

The accounts of travellers and naval expeditions are the only evidence we have so far on fishing in the medieval Ionian and Aegean Seas. There is also evidence of twelfth-century Byzantine fishing of marine molluscs for 'industry', used to produce the highest grade of purple dye. Purple fishers from Athens, together with those from Euripus and Carystus in Euboea, operated off the island of Gayaros, located between Andros and Kea, to the south of Euboea. The extraction of purple from the molluscs took place in Athens, the dyeing itself in Thebes. Only the highest quality of silk was treated with this dye. In the twelfth century, Thebes was the main centre for the production of high-quality silk fabrics, intended exclusively for the Byzantine emperors and members of their close entourage. These fabrics, therefore, were not marketed. This expensive industry was entirely subsidised by the imperial court, and, after the conquest of Constantinople by the Franks and Venetians during the Fourth Crusade, the industry disappeared and, instead, silk was dyed with *kermes*, a high-quality solid colorant obtained from the pregnant female of parasitic insects. This took place in the Aegean and the Peloponnese.[63] However, to date, nobody has addressed the question as to why the extraction of purple from marine molluscs disappeared after 1204. Was it due to overfishing or other environmental repercussions that caused a scarcity of murex?

There is currently no study of the Byzantine and medieval marine environment and the history of the fishing industry in the Ionian and Aegean Seas and in the southeastern Mediterranean. The evidence presented so far for other regions points to the promise of interesting results the moment such a study is undertaken.

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[61] Tucci 1987: 103–45. The nutritional qualities of each ingredient are, however, mine, and were provided to me by a clinic dietician, Dr Varda Levi.

[62] *Expeditions to Russia and the Holy Land made by Henry Earl of Derby* (ed. Toulmin Smith 1965): 219–32 (the geographic order of the places is mine).

[63] Cardon 2003: 469–83; Jacoby 2005: no. xii, on p. 23 the author discusses the dyeing of silk with purple extracted from marine molluscs in the pre-1204 period.

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6. Archaeological evidence

The relevant archaeological finds include fishing gear (net sinkers, hooks, net repair tools and auxiliary equipment), shipwrecks, ichthyoarchaeological data and 'industrial' facilities for fish processing.

The only assemblages of fishing gear from the seventh century AD that have been thoroughly studied and published are those found in shipwrecks along the Aegean coast of Asia Minor and in coastal settlements along the Levantine shore, including Israel. It is argued that the standardisation of fishing gear, in terms of both sinkers and hooks, the typology of which did not change much from the Bronze Age onwards, makes it virtually impossible to date them unless they are found in dated archaeological contexts or bear clear identification signs.[64] The fullest classification of fishing-net sinkers for the eastern Mediterranean was presented in 2002 by Galili, Rosen and Sharvit, based on finds from underwater exploration in the vicinity of Haifa; a *longue durée* typology of all types of fishing gear and their application, based on their previously-published studies, was recently offered by Galili and Rosen.[65] Therefore, only fishing gear associated with wrecks will be discussed here, including consideration of the wrecks themselves and their wider context, and some suggestions will be made regarding their use beyond fishing as well as the occupations of their owners. Only four shipwrecks with fishing gear have been fully excavated and studied to date. These are detailed below, in chronological order.

6.1 An early seventh-century vessel

A vessel of the early seventh century was found on a steeply sloping seabed at a depth of 32–9 m at Yassi Ada off the southwestern coast of Asia Minor, opposite the island of Rhodes. The latest coin found on the vessel dates to AD 625/6, and it was presumably wrecked soon afterwards.[66] It was a small, narrow-hulled ship with a keel length of 12 m and a deck length of 20.5 m; it had a beam of 5.2 m, a breadth-to-length ratio of 1:4 and an estimated displacement of 73 tons. The loading capacity (crew, cargo and passengers) is estimated at 60 tons in calm weather and 50 tons in rougher.[67] The fishing gear included 38 weights of various sizes that could be used for net or line fishing, miscellaneous lead pieces probably used in the manufacture of fishing weights on board (as is suggested by a bronze or copper spoon heavily encrusted with lead on its rim that points to it having been dipped into molten lead),[68] two net needles for repairing nets and a wooden spreader. The sizes of the weights suggest three possible types of small net were used: (1) a casting net used by one person and suitable for mackerel, horse-mackerel and other pelagic species; (2) a draw net suitable for grey mullet, mullet and other shore fish (the shortness of the spreader in use for such a net found on the wreck – 30 cm from notch to notch – suggests it was a small net); and (3) a drift net for passing pelagic fish used while the ship was at anchor. The weights could also have

[64] Galili 2003; Galili, Zemer and Rosen 2013; Szulc-Kajak 2013.
[65] Galili and Rosen 2013.
[66] Bass 1982: 311–19.
[67] Steffy 1982: 65–86.
[68] Katzev 1982: 280, figs 12–8, MF 23.

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been used for line fishing, either with a hand line or, if a rod was used, with a tight line.[69] Utensils for lead casting, which were also recovered, led to the conclusion that lead artefacts, including hull patches and fishing-net sinkers and net weights, were cast as a part of the net making and mending activities carried out on board the ship.[70]

6.2 A mid-seventh century shipwreck

A mid-seventh century shipwreck was located in shallow water at a depth of 1–2 m in the lagoon of Dor (Tantura) on the central Carmel coast a short distance south of Haifa. The latest coins found in the wreckage were dated AD 659–663/4; thus the vessel will have been wrecked not much later.[71] The fishing gear found includes lead fishing-net sinkers, for cast nets and a seine, an iron fishing spearhead (290 mm long, 155 mm wide and weighing 569 g) with evenly-distributed barbed prongs and an iron grid forming a shallow, flat-bottomed ellipsoid basket (460 mm long, 240 mm wide, 100 mm deep and weighing 1700 g), for use as a beacon that could be used to attract fish during night fishing. The latter item is a unique find; it is the only evidence of its kind from the Byzantine and medieval eastern Mediterranean for such a fishing practice. The authors claim that the absence of fishing hooks may testify to the fact that this assemblage represents the professional kit of a fisherman specialised in the art of fishing with such a device (an art that is still practised today at night near the coasts, in order to catch fish with nets and to harpoon octopodes). One hundred and fifty nine fishing-net sinkers were recovered. A lead sounding-weight shaped like a tall conical bell, an essential instrument for both fishermen and navigators, was also found. In addition to estimating water depths, sounding-weights can, with the help of a sticky material (such as tallow) placed in a cavity at the base, be used to bring up a sediment sample which allows for the study of the look, smell, texture and taste of the seabed. Sounding-weights can also be used to help locate corals, sponges and fishing grounds offshore.[72]

6.3 The Tantura F wreck

The Tantura F wreck was also discovered in the Dor lagoon, about 70 m offshore under 1 m of water and an additional 1.5 m of sand mixed with shells and stones. It was a fishing coasting vessel c. 15 m long with a beam of 5 m. AMS radiocarbon dating and ceramic analysis point to it dating between the mid seventh and the early eighth century AD. The only fishing gear recovered was a needle that could have been used for repairing fishing nets. However, the large amount of fish remains in the hull supports the idea that the vessel was engaged in fishing.[73]

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[69] Kuniholm 1982 (the author, however, indicates reservations regarding the adaptation of the weights to a casting net).

[70] Kuniholm 1982: 296–310.

[71] Galili and Rosen 2007.

[72] Galili and Rosen 2007; Galili, Zemer and Rosen 2013.

[73] Barkai and Kahanov 2006. The archaeologists, however, unconvincingly tend to stretch the time limits: 'The mid-7th century can be justified by being after the Arab occupation of the region (641). However, stretching the date after the mid-8th century (the end of the Umayyad period) into the Abbasid period can also be considered. Thus the suggested date of Tantura F is between the mid-7th and the end of the 8th centuries': Barkai, Kahanov and Avissar 2010: 96.

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6.4 An eleventh-century wreck

A wreck dated to the eleventh century was found at a depth of 33 m off Serçe Limani on the southwestern coast of Asia Minor, opposite Rhodes. The vessel, 15.66 m long and with a beam of 5.2 m, had a boxy hull which would have allowed it to sail up shallow rivers. The vessel was dated by sixteen glass weights for pan-scales that bore the name of the caliph in Egypt and the year of his reign, 1024/5. The ship must have been wrecked soon afterwards. The fishing gear included the following items.

a. Over 900 lead net sinkers were found in three distinct piles that revealed that three nets – each 40 m long – were on deck at the time the ship sank. The sinkers were of Byzantine manufacture and their ubiquitous decoration attests to their Bulgarian origin. The crew brought the nets from their home port in the Sea of Marmara.
b. Nets were found that might have been made by joining together smaller nets belonging to different, but cooperating seamen. One or two of these nets were in baskets and one net was spread out for mending. The archaeologists identified a matching Ottoman net stored at the Bodrum Museum of Underwater Archaeology.
c. Near each net was a netting needle.
d. Eight bone spindle-whorls suggest that the crew were spinning goat-hair threads for their nets.
e. The net's foot line, i. e. the cord at the lower edge of the net to which sinkers were attached, was made from 212 strands of goat hair. Goat's hair was used because the hairs are long and do not absorb water (the same material is still used today in Turkey; thus there is a continuity from at least the eleventh century through the Ottoman period to the present day).
f. A fishing spearhead with twelve removable prongs and a wooden handle was also found. A similar modern Italian trident is used for catching cuttlefish. In Turkey, in the early twentieth century, this type of device was used for spearing fish attracted to the surface by lights at night, and sometimes for spearing octopuses. In addition, bones of tuna, tub gurnard and drum were also found on the deck. They had been caught by the crew with the nets, no doubt for their own consumption.[74]

All these wrecks share some common features. First, the ships were all of small to medium size, suitable for both coastal and riverine activities. Second, fishing was not necessarily the main occupation of these vessels, but commerce.[75] The cargo of the seventh-century Yassi Ada vessel consisted of provisions for the Byzantine troops fighting against the Persians. The ship belonged to the Church, on which Heraclius, the Eastern Roman emperor, relied to pay and supply his troops, since Church resources surpassed those of the state. The several bronze balances, three steelyards and several bronze balance pan-scales found with the wreck, along with weights of different weighing systems for the various types of cargo.[76]

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[74] Bass, Matthews, Steffy and van Doorninck 2004: 399–435.

[75] The excavators of the mid seventh-century shipwreck at Dor do not specify the cargo connected to commerce; however, a steelyard counter-weight in the shape of a female bust is noted, associated with other steelyards bearing Greek inscriptions that were used for various commercial purposes: Galili and Rosen 2007.

[76] Van Alfen 1996.

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The thirty amphorae, typical of marine transportation, found in the Tantura F wreck suggest that the vessel was engaged in local commerce, mainly of fish products, along the Israeli coastline down to Egypt. In twenty of the storage jars, a residue of small fish bones was found. These could have contained either fish sauce or pickled fish, *salsamenta*. If the contents were fish sauce, then the presence of bones suggests *allec*, the less expensive variety of sauce. Since the amphorae were broken, sea water had contaminated their contents. The fish remains in eight amphorae were analysed and identified as whole *tilapia* (St Peter's fish), a freshwater fish. The bone sizes indicate tiny fish and suggest they were caught during the breeding season. That only one species of fish was used indicates a high-value product, i. e. *salsamenta*. The place of origin is, however, unknown. The jars were almost certainly manufactured in the Lower Nile region; however, the resinous linings of the jars suggest they were being reused. They might have originally contained wine and only later been used to store fish. In other words, the place of manufacture of the amphorae does not necessarily identify the origin of the fish. This could well have been one of the rivers along the Israeli coastline. The scholars suggest the fish products were purchased from local fish processors along the Israeli coastline, either at Dor or Caesarea, although there is no clear indication for sauce production at this period in either place.[77] It is more plausible that they were acquired at the facilities on the Taninim river, north of Caesarea. We should bear in mind the date, i. e. the Ummayyad period. In other words, either the customers were Christian Byzantines or, if they had converted to Islam, they still retained their traditional eating habits.

The main cargo of the eleventh-century Serçe Limani ship consisted of glass cullet, two tons of raw glass chunks and one ton of broken glass vessels, together with 'imported' Islamic glass vessels; it was nicknamed the 'glass shipwreck' by the investigators. The ship also carried wine in amphorae; the graffiti or stamps on the amphorae together with isotope analyses of the metal artefacts prove that the crew was Bulgarian, from a Byzantine-Slavic community on the shore of the Sea of Marmara, not far from Constantinople. The ship was engaged in coastal navigation and commerce with one of the Fatimid Levantine ports,[78] most probably Tyre,[79] and came to grief on its return journey. The personal artefacts of the members of the crew and the people on board, and their locations on the wreck, could tell us much about the social ranks, their eating habits and daily life. One common occupation was fishing.

The double function, so to speak, of the vessels points to the multiple occupations of their crews, i. e. commerce alongside fishing or vice versa. One could safely speculate that such a situation was not accidental, but a consequence of the disasters that had occurred in the sixth century: starting with the great plagues and the political and military calamities that almost nullified the territorial conquests of Justinian I, followed by the Slavic incursions

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[77] Barkai, Lernau and Kahanov 2013. The fact that remains of identical fish were found at Caesarea in a sewage canal dated to a later period (Abbasid) does not attest to a production industry at Caesarea, as claimed by the authors. It definitely does not validate the conclusion that Caesarea replaced the industrial fish production along the western Mediterranean and eastern Atlantic coasts of North Africa and the Iberian peninsula, as also claimed by the authors. The Tantura F wreck perhaps provides the sole material evidence for the fish-sauce trade at this period along the eastern Mediterranean coast, as further claimed by the authors; however, as noted above, textual evidence testifies to *garum* consumption in the Byzantine empire even after its disappearance in the West.

[78] Bass, Matthews, Steffy and van Doorninck 2004: 363–97.

[79] For the historic economic context, ports of call and navigation routes, see Gertwagen 2009.

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and settlements in the Balkans in the late sixth century, the assassination of Maurice in 602 and the temporary Persian conquest of Syria-Palestine-Egypt in 614. These disasters, which reached their climax in the 640s with the final Arab conquest of the Levant, Egypt and North Africa, affected the structure of the state, its finances and the possibilities of trade.

In 618 the *annona* system of grain shipments from Egypt stopped for good.[80] Merchants and shipowners who suffered as a consequence must have either left their occupation in favour of fishing or alternatively, added fishing to their more limited commercial activity. Another factor was a change in nautical technology, i. e. the transition in shipbuilding method from the expensive and slow 'shell-first' construction to the quicker and cheaper 'frame-first' method. This process had already begun at the turn of the sixth century and reached its final phase by the early eleventh century. The Tantura F vessel, for instance, was built using the 'frame-first' technique, which came to dominate Mediterranean shipbuilding from around the year 1000 onwards.[81] Only shipowners still supported by the state or rich institutions, such as the church, could afford to retain some features of the expensive older 'shell-first' building technology.

The revival of long-distance trade after the turn of the millennium would explain the number, types and distribution of weapons found on the Serçe Limani vessel, along with tools that could be used as weapons, like fishing implements and carpenter's tools. The assemblage of potential weapons exceeded what was needed for the basic defence of such a vessel. The scholars therefore convincingly suggest that the ship's crew were engaged in piracy alongside commerce[82] and, of course, fishing.

In this context, it is interesting to note that under Byzantine sea laws of the seventh century, the crew of a vessel sailed *ad partem*, that is, for a share of the profits rather than a fixed wage. The owner-captain received half the profits; the other half was divided amongst the crew. In the case of failure, all losses were carried by the individual who had invested the capital. Fishermen and mariners did their utmost to complete their ventures successfully, in order to profit from them, and employed all means to do so, including piracy.[83]

Another important area illuminated by the evidence of the Serçe Limani wreck, which may extend to other vessels, is the hierarchical division of social and everyday life on board. This is suggested by the allocation of living space on board, and the different types of food and gaming pieces. However, the common occupations of everybody on board, without any class differentiation, were fishing and mending fishing nets.[84]

Some of the wrecks and their contents also offer hints as to the origin of the merchants or ship owners. This is indeed clear in the case of the seventh-century Yassi Ada and the eleventh-century Serçe Limani wrecks. It is indirectly suggested in the case of the Tantura F wreck; analyses of wood samples from the hull and the mast point to Turkey as the place of origin. However, the place of the purchase of the cargoes and their destinations remain enigmas.

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[80] Laiou and Morrison 2007, 24; Dagron 2002, 450.

[81] Gertwagen 2014, 158–9.

[82] Bass, Matthews, Steffy and van Doorninck 2004: 363–97.With the further increase in maritime commerce in the following centuries, it was common for commercial ships to be engaged in piracy: Gertwagen 2013.

[83] Jackson 1989: 605–8.

[84] Bass, Matthews, Steffy and van Doorninck 2004: 363–97.

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Dor lagoon is a dangerous anchorage; it is difficult to manoeuvre in, even for those who are familiar with it.[85] The shipwrecks inside the lagoon attest to the crews' unfamiliarity with its treacherous features. One could therefore safely assume that the Tantura F vessel was wrecked after seeking refuge from an unexpected storm.[86] It is highly likely that this was also the fate of the other seventh-century wreck, although this was not found in its original wreckage location; during the wrecking event the vessel drifted ashore and broke up in the shallow water in the breaker zone, at a depth of 1–2 m.[87] Interestingly, attempts were not made to salvage the vessels, their cargoes or the fishing equipment, despite their short distance from the shore and the shallow depth of the water.

7. Ichthyoarchaeological evidence

7.1 Tel Taninim

Fish remains were found on the site of Tel Taninim, probably known in Latin as *Turris Salinarum*, south of Haifa, in a Byzantine church and in a nearby Crusader vault converted into residential quarters during the Mamluk occupation (fourteenth century). The ichthyo-archaeological evidence indicates that the identified fish were intended for local consumption. All the identified fish occur in local shallow seawater, or in freshwater sources in the Tel Taninim area. The fish belong to thirteen families and comprise forty individuals. The most common are listed below.

1. Grey mullet, of which two species were present: the flathead grey mullet, *mugil cephalus*, and the thin-lipped grey mullet, *Liza* spp. This fish is an important commercial species in present-day Israel, and is raised in fish farms.
2. Several species of sea bream (Sparidae): the gilt head sea bream, *Sparus aurata*, measuring 23–32 cm; sea bream, *Diplodus* spp., 18–26 cm long (this species is common along rocky coasts); striped sea bream, *Lithognathus mormyrus*, with an average size of 16 cm; sea bream, *Pagrus* sp., 25–26 cm long. All four species are carnivorous, feeding mostly on molluscs and crustaceans. They are a highly valued food today and are taken by net.
3. Groupers (Serranidae): large marine fish which occur in the warm waters of the eastern Mediterranean and are also common along the coast of Israel. Two species were represented: dusky grouper, *Epinephelus marginatus*, a small one 36 cm long; and golden grouper, *Epinephelus costae*, 29 cm long.
4. Two species of drumfish (Sciaenidae), which are also carnivorous and feed on small fish, crustaceans and molluscs: meagre, *Argyrosomus regius*, 21–47 cm long; and brown

[85] Barkai and Kahanov 2010.

[86] Barkai and Kahanov's claim that 'the present geographical setting reinforces the argument that no ship entered the lagoon unless it had a specific purpose, such as trade with known local merchants' does not make sense. It is very unlikely that the locals would have encouraged trade in a dangerous anchorage. It should be noted that there are natural protected havens adjacent to Tel Dor, north of the lagoon. Furthermore, if indeed there was anchorage for commercial purposes, we would expect salvage operations to have taken place after the storm had passed.

[87] Galili and Rosen 2007. There is no evidence for the authors' claim that the vessel was wrecked due to piracy or other hostile activity.

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meager *Sciaena umbra*, 35 cm long. Both species can be caught with nets or a hook and line.
5. Great amberjack, *Seriola dumerili*: usually a very large migratory fish with a maximum size of 2 m. It is fast-swimming and found world-wide. The single specimen from Taninim measured only 70 cm in length.
6. Sea bass, *Dicentrarchus* sp.: a small predatory fish that migrates inshore during the summer.
7. Parrotfish, *Sparisoma cretense*, 19–21 cm long. It is so-named for its gaudy colours and parrot-like beak, which it uses to scrape algae from encrusted rocks.
8. Cartilaginous fish, represented by several shark or ray vertebrae, i. e. calcified *centra* (not identified).

The local freshwater fish, originating from the Taninim river, include the following species.

1. The common species of St Peter's fish, *Tilapia zillii*. This is very common today in the Lake of Galilee and the rivers of Israel. At Tel Taninim it ranges in size from 16–31 cm. This species may have been the species used in the *garum* or *salsamenta* found in the Tantura F wreck.
2. The Nile catfish, *Clarias gariepinus*. This ranges in size from 30–70 cm. It occurs naturally in Israel, in the Lake of Galilee and in rivers, including the Tanninim river, as well as in rivers in North Africa.

Piscinae (fishponds) of the Byzantine and early Muslim periods were also uncovered at the tel. However, no fish bones were found. The archaeologists presume that this was because the fish raised in these installations were removed alive, having attained a certain designated size.[88] It is highly likely, however, that the remains were lost due to intensive cleaning of the excavation site without sieving the soil.

Abundant shellfish remains of three types were found: *Hexaplex trunculus* (*Murex trunculus*), *Murex brandaris* and *Purpura haemastoma*. The scholars claim that the main economic activity of the site was fish farming, most probably including small-scale production of sea-sourced purple dye, made from the abundant murex in the *piscinae* on shore. A question they do not consider, however, is whether this was used locally or exported to dyeing facilities elsewhere. During the Muslim period, from the early eighth century onwards, some fish farms were abandoned, and this economic activity never fully recovered.[89]

7.2 Caesarea Maritima

Fish remains found at medieval Caesarea came from two areas. The first is a former Byzantine warehouse (area LL). Fish bones were identified in an 'abandonment layer', dated to AD 640–690, after which the building was converted into Islamic residential quarters. The layer contained storage jars and amphorae. A total of 90 fish bones were identified, representing nine families and twenty individuals. The fish were being stored for local distribution within the city. Fish remains were also recovered from cesspits belonging to the Islamic occupants living in these quarters, providing evidence of the meals consumed here. The remains in-

[88] Fradkin and Lernau 2006: 211–22.

[89] Stieglitz 2006: 88–92, 215–6, 221–2 table 10, 226–7.

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clude 148 bones representing thirteen families and 61 individuals. Fish remains were also recovered from the Crusader phase of these houses. Seventy five bones were identified, representing eight families and 30 individuals. Since in both the early Islamic and Crusader periods the fish remains recovered included head bones and vertebrae, the fish had most likely been bought fresh from the market.

Area TP consists of Islamic and Crusader houses and a Fatimid and Crusader monumental public residence, most probably the dwelling of Crusader knights. Eleven fish bones were found in cesspits beneath the Islamic residences; they were identified as representing four families and seven individuals. The Crusader assemblage, also from cesspits and the drainage system, included 43 bones, representing nine families and 24 individuals.

Fifty-nine percent of the identified specimens were local marine fish. The most common were grey mullet (Mugilidae), of medium-size and ranging from 22–43 cm in length. Three species were represented: the flathead grey mullet (*Mugil cephalus*), the thin-lipped grey mullet (*Liza* spp.) and the thick-lipped grey mullet (*Chelon labrosus*). There was also a small specimen of dusky grouper with an estimated length of 38 cm.

Other fish represented in significant numbers are several species of sea bream, some similar to those found at Tel Taninim (*Pagrus pagrus*) and measuring 42–43 cm in length. The gilt-head sea bream (*Sparus aurata*) is a shallow-water species and often enters brackish waters. Those found at Caesarea range from 25–37 cm in length. The striped sea bream (*Lithognathus mormyrus*) is a smaller sparid and a gregarious species, sometimes swimming in large schools. Two species of drum were identified. Meager (*Argyrosomus regius*) and brown meager (*Sciaena umbra*) both range from 34–56 cm in length. Grey triggerfish (*Balistes carolinensis*) is a marine species and usually found in warm inshore waters in rocky or seaweed-covered areas. Bluefish (*Pomatomus saltatrix*) is a large ferocious predatory fish, up to 50 cm in length. It lives in large schools in open waters but enters coastal waters to prey on other fish. Horse mackerel (*Trachurus* sp.) is a smaller fish, but is also carnivorous and lives in schools. It is common along the Mediterranean coast in the summer, but migrates offshore to deep water in the winter. Sea bass (*Dicentrarchus* sp.), another marine predatory fish, also migrates inshore during the summer where it frequently enters estuaries and ascends rivers. Snapper (*Lutjanus* sp.) is also a marine carnivorous fish. Herring (Clupeidae) is typically a small fish and may be found in marine, fresh and brackish waters.

Local freshwater species include Nile catfish (*Clarias gariepinus*). It makes up a significant proportion of the total faunal assemblage and ranges from 42–100 cm in length. Almost all parts of the fish, including skulls and vertebrae, are represented. Since the head of this fish is quite large and heavy, accounting for about one-third of its total weight, and is inedible, the presence of cranial bones indicates that this fish was captured nearby. The common St Peter's fish (*Tilapia zillii*), ranging from 14–32 cm in length, like many other Tilapias, may adapt to shallow marine waters and has been caught in the Mediterranean close to the shore.

Barbel (*Barbus* spp.) is a kind of carp (Cyprinidae), it is a strictly freshwater fish and common in Israel's Lake of Galilee and other waters of the Jordan river system. This local freshwater fish was represented by only a few specimens.

Two freshwater fish identified at Caesarea are not to be found in present-day Israel: five individuals of Nile perch (*Lates niloticus*), ranging from 60–110 cm in length, and one bagrid catfish (*Bagrus* sp.). These are fish occurring naturally in the Nile as well as in other rivers and lakes of Egypt. The excavators suggest that these were imported. However, they also point out that since these species are common over a long time period on various exca-

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vation sites across Israel, a definitive answer to this question must await additional studies, such as isotope and DNA analyses.[90] I would add that the extremely small number of individuals found can hardly point to trade.

Tel Taninim, the Taninim river and Caesarea are the only Byzantine and medieval coastal sites along the Israeli shore at which ichthyoarchaeological remains have been sieved and analysed. However, the evidence provided by the Geniza letters and the western sources cited earlier helps to fill the gaps left by insufficient finds or careless archaeological work.

8. Concluding remarks

This paper is a pioneering review study of human and marine animal population interactions in the Byzantine and medieval eastern Mediterranean. It consciously ignores the climate aspect, although some scholars argue for direct interaction between climate, temperature, salinity and numerous other physical, chemical and biological processes that influence fish biomass.[91] However, no study has yet been undertaken on the effects of climatic conditions on the marine ecology and environment of the Byzantine and medieval eastern Mediterranean; this has been done only for Europe.[92] It should be noted that only recently have climatology studies regarding the Byzantine and medieval eastern Mediterranean commenced. These are interdisciplinary, integrating historic data, various types of scientific data and archaeological evidence. However, they, mainly focus on the effects of the climate on human societies and political structures.[93]

Methodologically, the present paper highlights the importance of multi- and interdisciplinary study of the ecology and environment of the Byzantine and medieval eastern Mediterranean across c. 900 years, by employing historical, archaeological and ichthyologic research in combination with ichthyoarchaeological studies in a way that enables these disciplines to complement each other and illuminate the information yielded by each. For example, archaeological finds present the equivalent material evidence for the fishing devices described in historical documents, as well as for the marine animal species. Moreover, the archaeological finds fill lacunae in the historical data: about fishing installations (which are also proxy data for the migratory behaviour of various marine species), the trade in fish products and the people and vessels involved. Zoo-archaeology contributes to the definition of the marine animal populations and also provides evidence regarding culinary habits, as convincingly suggested by Van Neer and Ervynck;[94] i. e., when ichthyoarchaeological data are interpreted within a wider anthropological framework, they yield a better understanding of why certain species were present on, or absent from, the menu.

Nevertheless, the information provided by this paper is very fragmentary, and there are grave lacunae in terms of the time periods and geographic areas covered and the archaeological and historical evidence. Chronologically speaking, the Byzantine period is the most informative. The archaeological evidence is particularly rich along the Israeli coastline, with a statistically lower percentage of finds – although very significant ones – along the eastern

[90] Fradkin and Lernau 2008.
[91] Glantz 1992: 1–7; Boero, this volume.
[92] Hoffmann 2000; Fagan 2002.
[93] McCormick et al. 2012; the controversial book by Ellenblum 2012; Haldon et al. 2014.
[94] Van Neer and Ervynck 2002: 204.

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coast of the Aegean and an almost total lack of data from any other areas. The reasons for this are mainly the absence of systematic excavations, underwater or on land, and a lack of attention to ichthyoarchaeological remains. From a historical point of view, this paper surveys both the published historical documentation and modern studies. In most, modern studies the focus on eco- and environmental history is minor or indirect, because these are not the main interests of the writer. The majority of documents remaining to be explored are unpublished and require extensive palaeographic skills that few scholars possess.

Despite the fragmentary information it offers, this pioneering paper provides some interesting insights about fishing within a broad context: marine environment, culinary and cultural habits, maritime trade and industry, marine technological achievements. It also suggests new interpretations of vessels, social status and occupations involved in various aspects of the fishing industry. In other words, the catching, processing and consuming of fish, shellfish and other marine animals involved conscious decisions motivated by complex social, economic, culinary and cultural motives.

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